R & D facts

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Circulating Fluid-bed Combustor

CONTACT POINTS

Lawrence J. Shadle
Physical Scientist
304-285-4647
lawrence.shadle@netl.doe.gov

Diane (DeeDee) Newlon
Technology Transfer Manager
304-285-4086
r diane.newlon@netl.doe.gov

ADDRESS

National Energy Technology Laboratory

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4469 fax

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4604 fax

WEBSITE

www.netl.doe.gov/products/r&d

Capabilities

The objective of this bench-scale CFBC facility is to provide more comprehensive support to the Advanced Combustion, Gasification, and Carbon Sequestration Technologies Programs, and to a lesser extent the Fuel Cell, and Gas Turbine Programs. The Office of Science and Technology (OST) will design, construct and operate this multi-functional facility in the Morgantown campus. The facility will provide a tool to characterize a variety of fuels such as coal, biomass, solid wastes fuels etc., conduct gas cleanup research, as well as possibly be a CO2 gas source for carbon sequestration studies, and possibly provide syngas for fuel cell/turbine research.

The circulating fluidized-bed combustor is made up of two sections. The lower section, the mixing zone is 6-in diameter, 12-ft height. Solid fuels and air will be fed into the mixing zone. The mixing zone will provide a longer residence time (2 seconds) and the desired temperature (1,800°F) for the complete combustion of any organic compounds. The upper section, the riser is 4-in diameter, 36-ft height that is made up of refractory-lined carbon steel spool pieces. Combustion of carbon and CO or other hydrocarbon will be completed along the riser where secondary air will be injected at the top of the mixing zone. Gas and solids exit the top of the riser and are separated by a high through-put, high efficiency cyclone. Solids collected from the cyclone are then, returned to the bottom of the mixing zone through a loop seal nonmechanical valve. Hot flue gases with fine particles exit from the cyclone will be directly quenched with water spray and solids captured by a barrier filter. Dry gas grab samples will be taken after series of knockout pots to remove the moisture from the flue gas for analysis by gas analyzers for CO_2, CO, SO_2, NO_x, O_2, and hydrocarbon or/and a GC/MS. Ash can be withdrawn from the bottom of the fluidized bed through a mechanical screw and/or through an overflow tube in the nonmechanical valve (a loopseal). X-ray spectrometry and atomic absorption spectrometry will be used to analyze solid samples collected from the cyclone as well as from the barrier filter for various heavy metals and mercury.

The range of operating conditions for the circulating fluidized bed combustion system is:

Parameters	Conditions
Operating Temperature	1,500-1,800 °F
Pressure	0 - 50 psig
Firing Rate	58,000 – 250,000 Btu/hr
Fuel feed rates	4.2 – 18.2 lb./hr
Fuel size	1/8” x 0 (200 - 3000 :)
Air feed rate	60 - 260 lb/hr
Ca/S Molar ratio	3.0
Sorbent feed rate	Limestone (1.0 – 5 lb/hr)

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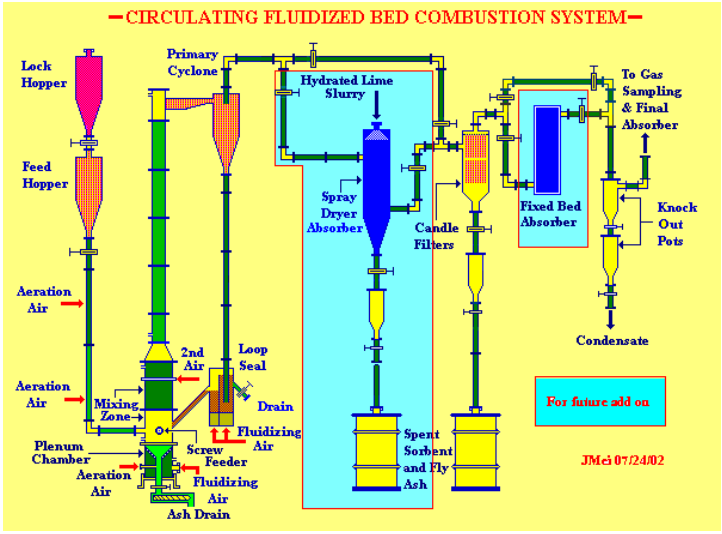
Future Construction and Operation

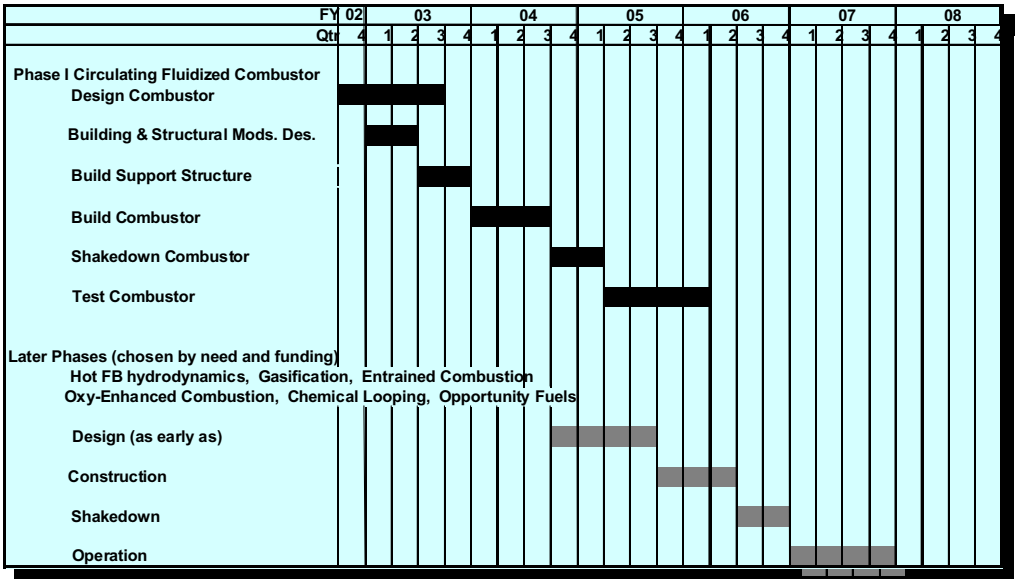
The bench-scale circulating fluidized bed combustion/gasification facility has been designed to be a flexible unit such that the facility can service multiple purposes. A spray dryer absorber and a fixed bed absorber will be added to the facility in future operation for cleaning up of heavy metals and mercury when solid waste combustion experiments are to be conducted in the facility. If available, separation membrane will be added to the facility to provide oxygen to the facility for oxygen-blown gasification and oxygen-enhanced combustion experiments and to separate hydrogen from the fuel gas during future gasification runs. Future experiments will also include chemical looping combustion for CO_2 separation and sequestration. Furthermore, the unit can also be used for novel particulate cleanup devices (PCDs) and/or barrier filter materials testing. In such case, high temperature flue gas will be available to test novel PCDs and different novel barrier filter materials (for example, the porous metal filter media, etc.). The facility, therefore, can provide a platform for combustion and emission characterization of various solid fuels, for testing of novel combustion/gasification technology concepts and for long term testing of novel PCDs and barrier filter materials.

Opportunities

The Circulating Fluid Bed Combustion unit provides the following opportunities:

- A user's test facility for private industry to test specific component designs and configurations.
- Better understanding of operational principles of combustion, environmental emissions, and gas clean-up.
- Data to verify the mathematical models; use these data to develop stochastic and engineering models.
- Design and scale-up data of Circulating Fluid Bed process systems.
- A platform to develop and test instrumentation and novel non-mechanical valves, down-comers, and other devices.
- A training simulator for plant operating personnel.





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